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A NEW FAUNA FROM THE FORT UNION OF MONTANA[1]

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INTRODUCTION

One of the outstanding results of the third Scarritt Expedition of The American Museum of Natural History during the summer of 1935 in the Crazy Mountain Field of central Montana was the opening of a new fossil quarry, to which the name Scarritt Quarry is applied, in the Fort Union group. Fifty mammalian jaws and numerous isolated teeth were obtained, as well as a few reptile remains and a number of invertebrates. The mammals are described in the present paper.

Large collections have been made in this field, but at different localities, for the United States National Museum, mostly by Mr. A. C. Silberling. Description of these was started by the late Dr. J. W. Gidley, and is now being completed by me. The bulk of our 1935 collection is from the Gidley Quarry, as is the greater part of the National Museum material. Its preparation will not be completed for a long time, and no attempt will be made to describe it until the National Museum memoir is completed. The National Museum, however, has only a few surface scraps from the locality of the Scarrit Quarry, so that the small part of the 1935 collection here described does not duplicate that of the National Museum and its description prior to the completion of the longer memoir will assist in making the latter more complete and useful.

The Scarritt Quarry was developed at Locality No. 56 of Mr. Silberling's list and is situated in Sweetgrass County, Montana, in the northwest quarter of section 13, township 5 north, range 14 east. According to a reconnaissance survey made by Mr. Silberling and me in 1932, this is about 2000 feet above the base of the "Fort Union No. 3" and about 2150 feet above the rich Gidley Quarry (of Middle Paleocene age) which is in the Lebo formation, Fort Union group.[2] Further data will be given in the National Museum memoir.

[1] North American Publications of the Scarritt Expeditions, No. 1. (The series of "Publications of the Scarritt Expeditions" so far issued relates to South America and will be continued, separately numbered from the North American contributions.)

[2] The "Fort Union No. 3" of this field immediately overlies the Lebo. It presumably includes equivalents of the Tongue River and Sentinel Butte. It is, however, very doubtful whether these units can really be recognized here, and it would be unwarranted to consider the Scarritt Quarry fauna as defining the age of either of them.

This site was discovered by Mr. Silberling some years ago and despite its poor exposure and generally unpromising aspect he considered it to be a probable quarry site and urged our exploration of it. It was accordingly opened on August 28, 1935, by a party consisting of Mr. H. S. Scarritt, Dr. Walter Granger, Mr. A. C. Silberling, Mr. Albert Thomson, and me, and was worked intermittently until about the end of September, principally by the four last named collectors. The fossils are sparsely but rather evenly distributed over a large area and the site promises slow but long-continued production. Our party averaged about one jaw per day per collector.

Like almost all that is known of the mammals of the Fort Union of Montana, this discovery is due primarily to the skill and energy of Mr. Silberling. The work was made possible by the generosity and interest of Mr. H. S. Scarritt. Mr. Albert Thomson not only collected many of the specimens here described but also prepared all of them, work requiring the greatest skill and patience. The illustrations in this paper were drawn by Mrs. Mildred Clemans.

COMPOSITION OF THE FAUNA

The Scarritt Quarry fauna[1] consists almost exclusively of small or minute mammals of unguiculate, insectivorous or frugivorous habitus. One of the commonest forms, *Litolestes*, is, indeed, believed to be a condylarth and hence, in the broadest sense, of ungulate relationship, but its dentition is rather of insectivorous than of herbivorous type and there is little doubt that its toes were clawed (as they are known to be in some similar condylarths) and that its general habitus is unguiculate. Incidentally, its two species include the smallest known condylarths.

The forms identified and the numbers of jaws and of teeth present in the collection are as follows:

	Jaws			
	Upper	Lower	Both	Teeth
MULTITUBERCULATA				
Ptilodontidae				
Ectypodus hunteri	2	4	..	27
INSECTIVORA				
Leptictidae				

[1] It is universal custom to speak of a "fauna" in such cases, and I shall follow this usage, but it is not correct. A fauna is the whole of a natural assemblage of animals living together in one region and at one time. The collections that we call faunas are in every case strongly biased samples drawn from one or more faunas, and are never really faunas themselves in any accurate sense.

	Jaws			
	Upper	Lower	Both	Teeth
Leptacodon cf. *tener.*	..	1	..	..
Pantolestidae				
Bessoecetor thomsoni	3	9	1	..
Cf. *Palaeosinopa* sp.	..	..	..	1
Mixodectidae				
Elpidophorus patratus	1	1	1	5
Incertae sedis				
Apator asaphes	..	1	..	..
PRIMATES				
Plesiadapidae				
Plesiadapis anceps	..	..	1	6
Carpolestidae				
Carpodaptes hazelae	1	3	..	..
Family uncertain				
Phenacolemur frugivorus	..	1	..	..
CARNIVORA				
Arctocyonidae				
Cf. *Chriacus sp.*	..	..	..	1
CONDYLARTHRA				
Hyopsodontidae				
Litolestes notissimus	..	19	1	..
Phenacodontidae				
Tetraclaenodon sp.	..	..	..	1
PANTODONTA				
Pantolambdidae				
Pantolambdid indet.	..	..	..	2
Totals	7	39	4	44
		50		
			94	

The general facies is more clearly shown by the following tabulation:

Zoölogical and Ecological Types	Percentage of Collection
Small multituberculates	36%
Small insectivores, *Bessoecetor* alone	15%
Larger, more specialized insectivores, *Elphidophorus*	9%
Small, probably frugivorous primates, *Plesiadapis, Carpodaptes, Phenacolemur*	13%
Very small condylarths of unguiculate habitus, *Litolestes*	21%
All others	6%

In both tabulations isolated teeth that have not been identified are omitted. This somewhat increases the apparent proportion of *Ectypodus*, but otherwise does not much affect the figures.

There are three other known deposits of approximately the same age and somewhat similar facies: the Mason Pocket in the Tiffany (see Simpson, 1935a), the Bear Creek Fort Union fauna (see Simpson, 1929, and papers there cited), and the Princeton Quarry in the Fort Union (see Jepsen, 1930). Collections from these sources have in common these striking points.

1.—All are microfaunas, with large or even medium-sized animals rare or absent.
2.—Animals of ungulate habitus are very rare.
3.—Carnivores are very rare.
4.—Small mammals of insectivorous habitus (only in part true Insectivora) are abundant.
5.—Small, probably frugivorous primates are common.

It may be inferred with some probability that the faunas are largely arboreal in all four cases and that their resemblances are due in large measure to this circumstance.

In spite of this general ecological agreement and of the approximate agreement in age, the zoölogical compositions of the four faunas are very different. The Mason Pocket contained abundant multituberculates, opossums (elsewhere unknown at this stage), and primates, and very little else. The Bear Creek fauna consists largely of tiny insectivores, plagiomenids (elsewhere unknown at this level), and primates, with multituberculates, common in the other three faunas, extremely rare. The Princeton Quarry fauna is the closest of the three to the Scarritt Quarry fauna. Its general make-up is very similar, the only striking differences being the fairly common occurrence in it of a somewhat larger hyopsodontid (or ? dichobunid) and the absence of mixodectids.

Correlation

The evidence of the various elements of this fauna on the age of their horizon is as follows:

Ectypodus hunteri: genus typically Upper Paleocene, doubtfully reported in the Middle Paleocene: species distinctive, but near *E. musculus*, of the Tiffany.

Ptilodontid indet.: no value for precise correlation.

Leptacodon cf. *tener:* genus Middle and Upper Paleocene; species very close to *L. tener*, Tiffany, and *L. packi*, "Tiffany-Bear Creek" Fort Union.

Bessoecetor thomsoni: distinctive genus, possibly including a more primitive ally in the Middle Paleocene, allied to but more primitive than *Palaeosinopa* of the Lower Eocene.

Cf. *Palaeosinopa* sp.: genus typically Lower Eocene, but also reported in Paleocene.

Elpidophorus patratus: very close to *E. elegans* in an Upper Paleocene faunule of the Paskapoo; more distant allies in Middle Paleocene and Lower Eocene, but evidently not in the same line of descent as any of these.

Apator asaphes: no value in correlation.

Plesiadapis anceps: genus Upper Paleocene and perhaps Lower Eocene, but latest forms much more specialized; species closest to *P. gidleyi*, Tiffany, but apparently somewhat more primitive; distinctly more advanced than *Pronothodectes*, Middle Paleocene.

Carpodaptes hazelae: genus otherwise known only in Tiffany, species closely related or *C. hazelae* slightly more primitive, somewhat more primitive than *Carpolestes*, Bear Creek and Clark Fork; definitely more advanced than *Elphidotarsius*, Middle Paleocene.

Phenacolemur frugivorus: apparently same species in the Tiffany.

Cf. *Chriacus* sp.: genus Lower Paleocene to Lower Eocene.

Litolestes notissimus: genus otherwise known only in the "Tiffany-Bear Creek" Fort Union; closest known allies are in Middle Paleocene and not demonstrably less specialized, but evidently on different lines of descent.

Tetraclaenodon sp.: genus elsewhere reported only in the Middle Paleocene. Not well represented or exactly definable in this fauna, but unlike anything elsewhere known in the Upper Paleocene or later.

Pantolambdid indet.: animals of this general type known only in Middle and Upper Paleocene, but no value for exact correlation.

Out of ten definitely identified genera, two are unknown elsewhere but one of these (*Bessoecetor*) seems to be of Middle or Upper Paleocene type. Five occur in the Tiffany, one inseparable specifically (*Phenacolemur frugivorus*) and two (*Plesiadapis* and *Carpodaptes*) perhaps with slightly more advanced species in the Tiffany. Three of these Tiffany genera also occur in the Princeton Quarry, one (*Plesiadapis*) with a species perhaps still more advanced, while another Tiffany–Scarritt Quarry genus (*Carpodaptes*) is replaced in the Princeton Quarry by a more advanced ally (*Carpolestes*). One Scarritt Quarry genus (*Litolestes*) also occurs in the Princeton Quarry but is not known in the Tiffany. One genus (*Elpidophorus*) occurs elsewhere in the Paskapoo, in a faunule of definitely Upper Paleocene aspect. Finally, one genus (*Tetraclaenodon*) is known elsewhere only in the Middle Paleocene. The fauna has only two genera (*Leptacodon* and *Plesiadapis*, both poor correlative types in this case) in common with the Bear Creek, the facies of which is so different as to preclude close comparison.

The evidence thus very strongly favors Upper Paleocene age, and probably early Upper Paleocene, at least as old as the Tiffany and possible slightly older, although this is uncertain. The only dubious fea-

ture is the presence of *Tetraclaenodon*, which is replaced by *Phenacodus* in the Tiffany and elsewhere in the Upper Paleocene. This does not outweigh the otherwise conclusive evidence of Upper Paleocene age, and may be explained as a chance survival, as evidence of very early Upper Paleocene age, or as indicating the presence in the Upper Paleocene of a genus with molars like *Tetraclenodon*, but perhaps nevertheless more progressive in other respects.

TAXONOMY AND DESCRIPTIONS

MULTITUBERCULATA

Ptilodontidae

Ectypodus hunteri,[1] new species

TYPE.—Amer. Mus. No. 33865, right lower jaw with incisor, P_4, and M_{1-2}.

HORIZON AND LOCALITY.—Scarritt Quarry, Fort Union, Upper Paleocene horizon, Crazy Mountain Field, Montana.

DIAGNOSIS.—Length P_4, mean 4.55 ± .05, standard deviation .20 ± .04. Length M_1, type, 2.6. Length P^4, mean (four specimens) 3.0. Ratio length P_4 : length M_1, type, 1.8. Ratio length M_1: width M_1, type 2.0, one paratype 2.5. Serrations P_4 14–16, mode 15. Cusps, shearing edge P^4 8–9. Cusps M_1, one paratype 8 : 4.

This is a very distinctive species, but it seems to be referable to *Ectypodus* with little doubt. The incisor is of the usual *Ptilodus-Ectypodus* type. P_3 is present and has the usual styliform character. The most distinctive lower jaw character is the large number of serrations on P_4. Of the thirteen specimens on which they can be counted, there are 14 serrations on 1, 15 on 7, and 16 on 5. No other species of *Ectypodus* is known ever to have as many as 16 serrations, and only one, ? *E. russelli*, has been reported to have 15 as an extreme variant. No other species of *Ectypodus* seems to reach the very low length : width ratio of M_1 in the type of this species, but in one paratype this figure is as in *E. musculus*. Compared with the genotype, *E. musculus*, *E. hunteri* has P_4 longer and with more serrations and M_1 about the same length but averaging wider. Two of the specimens of M_1 and the one of M_2 available are so worn that the cusp numbers cannot be determined, but one specimen of M_1 has the cusp formula 8:4, whereas the known specimens of *E. musculus* all have 8:6.

Two upper jaw fragments each have P^{1-3}, which closely resemble those of *E. musculus* in form. There are several isolated specimens of

[1] Mr. Fenley Hunter, who worked in the Crazy Mountain Field during June, 1935.

P^4 which surely belong to this species. It is very closely similar to that of *E. musculus*, the best evidence of generic identity, save that it averages longer and with more cuspules, 8–9 as against the usual 7 in *E. musculus*, in harmony with P_4.

There is only one complete M^1 of this species in the collection. Its dimensions, 3.0 by 1.4 mm., are about those of *E. musculus*, but the cusps are less numerous, the formula being 7:11:8. There is also one isolated M^2, measuring 1.6 by 1.6, slightly larger than M^2 of *E. musculus* but closely similar in structure.

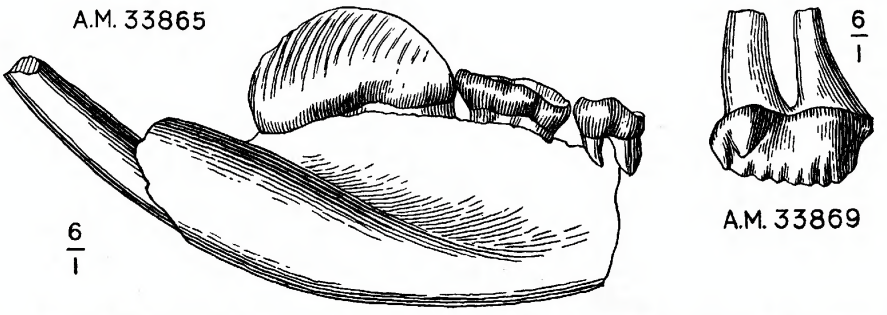

Fig. 1. *Ectypodus hunteri*, new species. Type, Amer. Mus. No. 33865, right lower jaw with incisor and P_4–M_2. Internal view. Distortion of the jaw has not been entirely corrected. Six times natural size.

Fig. 2. *Ectypodus hunteri*, new species. Amer. Mus. No. 33869, isolated P^4. External view. Six times natural size.

The other principal numerical data are as follows:

	Number	Range	Mean	Standard Deviation	Coefficient of Variation
Length P_4	15	4.2–5.0	4.55 ± .05	.20 ± .04	4.3 ± .8

Serrations of P_4:

No. Serrations	No. Specimens
14	1
15	7
16	5

Lengths of four specimens of P^4: 2.8, 2.9, 3.1, 3.3

Dimensions of type:

P_4	M_1		M_2	
L	L	W	L	W
4.6	2.6	1.3	1.5	1.3

Ptilodontid indet.

There is a ptilodontid M^1, Amer. Mus. No. 33826, in the collection that measures 5.9 by 2.8 and is thus about twice as large as this tooth would be in *E. hunteri*. Its cusp formula is 6:10:8. The specimen cannot be identified, but clearly represents a species not otherwise represented in the collection.

Leptacodon cf. tener

One lower jaw in the collection, Amer. Mus. No. 33829, with P_4–M_2 and the trigonid of M_3, is very close to *L. tener*. The paraconid of

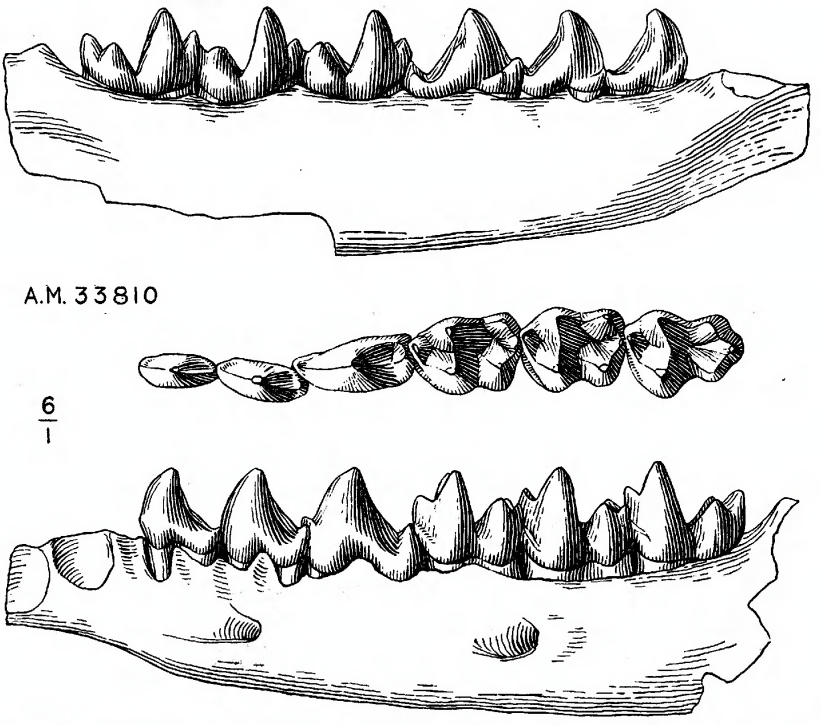

Fig. 3. *Bessoecetor thomsoni*, new genus and species. Type, Amer. Mus. No. 33810, left lower jaw with P_2–M_3. Internal, crown, and external views. Details of M_1 and of the external surface of the mandible have been clarified by reference to other specimens. Six times natural size.

P_4 is perhaps larger, the molar talonids relatively better developed, and M_3 less reduced, but these differences are slight, and do not warrant definite specific separation. It does not follow that the species are the same. Probably they are different, but with such extremely minute

animals, with a very stereotyped dental pattern, and represented by few and imperfect specimens closely related species may be indistinguishable. *L. packi* Jepsen is also very close to *L. tener* and to the present specimen from which it likewise is not distinguishable with certainty.

The dimensions are as follows:

P_4		M_1		M_2		M_3	
L	W	L	W	L	W	L	W
1.5	0.9	1.4	1.0	1.4	1.1	...	1.1

M_{1-3}: about 4.0

Pantolestidae

BESSOECETOR,[1] NEW GENUS

TYPE.—*Bessoecetor thomsoni*, new species.

DISTRIBUTION.—Upper Paleocene, Fort Union, Montana.

DIAGNOSIS.—Closely similar to *Palaeosinopa*, but upper molars more transverse, leptictid in aspect, anterointernal cingulum and hypocone less expanded; M^3 less reduced, with larger metacone; P_4 more elongate, prominent median anterior basal cusp, talonid slightly basined on internal side; lower molars with paraconid shelf low, compressed anteroposteriorly, talonid cusps more distinct than in *Palaeosinopa*, particularly on M_3. Known species small.

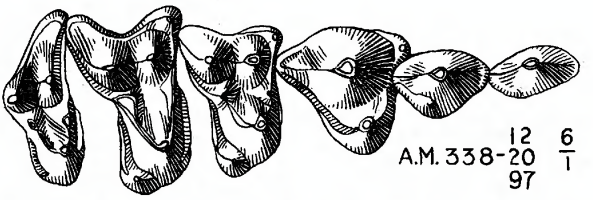

Fig. 4. *Bessoecetor thomsoni*, new genus and species. Restoration of right upper P^2–M^3 from parts shown by Amer. Mus. Nos. 33820, 33812, and 33897. No hypothetical features have been shown. Crown view. Six times natural size.

This genus is evidently closely allied to the *Palaeosinopa-Pantolestes* line, but the details given in the diagnosis and in the description of the type species sufficiently distinguish it. It is distinctly, although only slightly, more primitive than *Palaeosinopa*.

Bessoecetor thomsoni,[2] new species

TYPE.—Amer. Mus. No. 33810, left lower jaw with P_2–M_3.

PARATYPES.—Amer. Mus. No. 33812, right upper jaw with P^2–M^3 (M^{1-2} imperfect).

[1] *βῆσσα*, a wooded valley, + *οἰκήτωρ*, an inhabitant.

[2] Mr. Albert Thomson, who collected many and prepared all of the specimens here described.

Amer. Mus. No. 33820, skull fragment with left ? canine and P^1–M^3 (P^3 broken and P^3–M^3 poorly exposed) and right P^1 and P^3–M^1, and associated left lower jaw with P_4–M_3 (form imperfectly preserved).

HORIZON AND LOCALITY.—Scarritt Quarry, Fort Union, Upper Paleocene horizon, Crazy Mountain Field, Montana.

DIAGNOSIS.—Sole known species of genus. Measurements below.

With the badly crushed specimen of the facial part of the skull there is a large, one-rooted anterior tooth with simple enameled crown which is probably a canine, but no details can be made out. P^1 appears to have a single, compressed root and a low crown with a very small and vague heel. P^2 has two well separated roots and a laterally compressed main cusp, the posterior slope of which has a slight but sharp crest running to the small, noncuspidate heel. P^3 is similar but is larger, less compressed, and has a small posterointernal expansion with a rudimentary cuspule. P^4 has the main, outer cusp still larger and less compressed with a distinct parastyle and rudimentary metastyle. The posterior crest from the apex has a very slight thickening which may be a rudimentary metacone. There is a low but well distinguished protocone directly internal to the paracone (or amphicone). M^{1-2} are of promitive stamp, much as in the leptictids, with the three cones and two conules well developed. The parastyle is small and the metastyle is developed as a flat, ear-like shelf or spur projecting externally. Between these two styles the border is emarginate and there is no mesostyle. There is a slight anterior cingulum and a distinct, low hypocone which projects internally. M^3 has the parastyle developed as a spur, metacone reduced, no metastyle, and a posterior cingulum but no hypocone.

Incisors were evidently present and unspecialized, but their separate alveoli cannot be made out. The canine alevolus is single, circular, and slightly enlarged. P_1, from its alveolus, appears to have been small, one-rooted, and closely crowded between canine and P_2. P_{2-3} have a single, compressed cusp, crested on the posterior side, with a small low heel tending to form one cuspule, and are without other cuspules. P_4 is similar but larger, with a small anterior cuspule, heel cuspule more distinct, and a very slight internal talonid basin. The molar trigonids are moderately elevated above the talonids and each has a low distinct paraconid, submedian on M_1 and more internal on M_{2-3}, and lofty, subequal protoconid and metaconid placed almost directly transversely. On M_1 the talonid is wider than the trigonid, on M_2 they are about equal, and on M_3 the talonid is definitely narrower. The hypoconid

and entoconid are sharply differentiated and subequal. On all molars the hypoconulid is distinct and on the midline. On M_{1-2} it is much smaller than the other talonid cusps, and on M_3 it is slightly larger than the latter and projects posteriorly.

The horizontal ramus is long and slender, with strong mental foramina beneath P_3 and M_1. The lower border curves upward abruptly posterior to the dental region. The masseteric fossa, is bounded anteriorly (but not inferiorly) by a sharp, prominent, vertical crest.

Measurements of the type:

P_2		P_3		P_4		M_1		M_2		M_3	
L	W	L	W	L	W	L	W	L	W	L	W
1.6	0.7	1.8	0.8	2.6	1.1	2.5	1.7	2.3	1.8	2.6	1.8

LP_4–M_3: 9.5

LM_1–M_3: 7.0

Cf. **Palaeosinopa** sp.

A larger possible ally of *Palaeosinopa* is represented by a single upper molar, comparable to *P. veterrima* in size. Its affinities are doubtful.

Mixodectidae

Elpidophorus patratus, new species

TYPE.—Amer. Mus. No. 33857, left lower jaw with P_3–M_3 (the premolars imperfect), associated with right upper incisor and P^2–M^1 (P^3 imperfect).

PARATYPES.—Amer. Mus. No. 33856, right lower jaw with P_2–M_3. Amer. Mus. No. 33862, part of right maxilla with M^{1-2}. Amer. Mus. No. 33861, isolated left M^3.

HORIZON AND LOCALITY.—Scarritt Quarry, Fort Union, Upper Paleocene horizon, Crazy Mountain Field, Montana.

DIAGNOSIS.—M_{1-3} closely similar to those of *E. elegans* but paraconids slightly less internal, hypoconulid of M_2 (probably also M_1) more distinct, M_3 stouter, external cingula better developed, jaw stouter, masseteric fossa deeper and more sharply delimited.

Elpidophorus elegans, the type of the genus, was described (Simpson, 1927) from two jaw fragments, one with M_{1-2} and the other with M_3, found by Dr. Barnum Brown in the Paskapoo of Alberta. The peculiarity of its molar structure was emphasized and it was referred to the Oxyclaenidae with a query and with the understanding that the reasons for doing so were negative, not any positive resemblance to known oxyclaenids. At last the hope expressed regarding the genus and implied in its name has been fulfilled and its dentition now becomes well known and its true affinities are established, although not from further discoveries in the Paskapoo.

In this family the genera are in several instances extremely difficult to distinguish from the lower molars alone, so that the reference of this new species to *Elpidophorus* is not completely certain. The agreement is very close, however, certainly gives no basis for generic separation on the data at hand, and does give assurance that the relationship must be close. The following description is of *E. patratus* and the discussion of affinities also refers to that species, but probably will be found to apply to the type species as well and so to the genus as a whole.

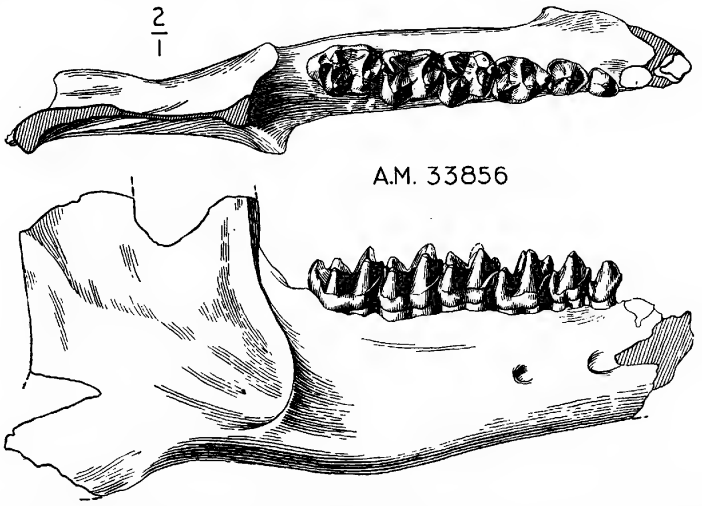

Fig. 5. *Elpidophorus patratus*, new species. Paratype, Amer. Mus. No. 33856, right lower jaw with P_2–M_3. Crown and external views. Twice natural size.

Fig. 6. *Elpidophorus patratus*, new species. Composite right P^2–M^3. P^2–M^1 from type, Amer. Mus. No. 33857. M^2 from paratype, Amer. Mus. No. 33862. M^3 from paratype, Amer. Mus. No. 33861 (reversed). Crown view. Twice natural size.

The crown of the enlarged upper incisor has not previously been known in any member of this family. With the type of *E. patratus* is an upper incisor not inserted in the jaw but almost certainly in true association with the type individual. It has a long, closed, slightlv curved root and a low complex crown. It has two terminal cusps, one smaller and medial and the other larger and lateral, and a basal cusp lateral to

these. All have sharp medial and lateral crests and are convex on both buccal and lingual sides. The crown as a whole is convex on the buccal and somewhat excavated on the lingual side.

A portion of the right maxilla of this specimen has two teeth, the second with the inner half broken away. There are also two loose upper teeth of the right side found in the matrix nearly in contact with this frament but not in place in bone. From this evidence of association and from the positive indentification of the most molariform of these teeth as M^1 by comparison with another specimen, it seems fairly sure that the teeth represented here are P^2–M^1. The element of doubt is mentioned because of the unexpected complexity of P^3 if correctly identified.

P^2 is a small and simple tooth consisting essentially of one high, sharp cusp surrounded by a cingulum which forms minute para- and metastyle. P^3 has paracone and metacone well distinguished but with connate bases and the paracone considerably larger. There are distinct parastyle, larger, and metastyle, smaller. The inner part of the tooth is broken, but from the root there was evidently a well developed protocone, probably with about the proportions of P^3 in *Cynodontomys*. This tooth is slightly more molariform than in *Cynodontomys latidens* (see Matthew, 1915, fig. 44) and closely resembles the supposed P^4 of *C. angustidens* (*loc. cit.*, fig. 48). It seems to me, however, that the teeth identified as P^4–M^1 of the latter species may be P^{3-4}, in which case they agree closely with the teeth so identified in *E. patratus*.[1]

P^4 is highly molariform but differs from the molars in the absence of a mesostyle, closer approximation and more convex outer faces of paracone and metacone, slightly less prominent and procumbent protocone, and slightly less distinct hypocone. The paracone is slightly larger than the metacone, and there is a well-developed parastyle. The agreement with P^4 of *Cynodontomys* is close.

M^{1-2} likewise agree closely with *Cynodontomys*. The three outer styles, including mesostyle, are prominent and make the paracone and metacone subcrescentic. The conules are strong and distinct. The protocone has a bulbous base and its tip is inclined forward. The hypocone is very small, even smaller than is usual in *Cynodontomys*. M^3 is

[1] The infraorbital foramen is often above or even immediately anterior to P^3 in *Cynodontomys* and *Microsyops*, and is above the anterior of the two teeth in the specimen in question. M^1 otherwise always has a mesostyle in *Cynodontomys* and the tooth so identified by Matthew in this specimen agrees with P^4 in the absence of a mesostyle. The two teeth resemble P^{3-4} of *C. latidens* more than M^{1-2} and while they are more advanced than P^{3-4} of *C. latidens* and this would be contrary to expectation, it clearly is not impossible. Finally, the resemblance to (probable) P^{3-4} of *E. patratus* is in itself an argument for this identification.

reduced, more oval, with the metacone small and metastyle and hypocone lacking.

The anterior alveoli are not well preserved in either of the available mandibles, but they show clearly that there was an enlarged, procumbent tooth and that at least one one-rooted tooth occurred between this and P_2. They suggest but do not conclusively show that there was another, somewhat smaller, single root between the single alveolus just mentioned and the enlarged anterior tooth. In *Mixodectes* (and *Indrodon*) there are three premolars preceded by a moderately enlarged tooth, probably a canine, and this in turn by the much enlarged tooth, an incisor. In *Eudaemonema* there are four premolars preceded by a moderately enlarged canine and by two incisors of which the median is the much enlarged tooth. In *Microsyops* and *Cynodontomys* there are three premolars preceded only by the much enlarged tooth. *Elpidophorus* thus might agree with *Eudaemonema* but probably has the anterior dentition more reduced. It may have the anterior dentition less reduced than in *Mixodectes*, but if not this region is closely similar. It surely has the anterior dentition less reduced than in the Eocene forms.

P_2 has two small, separate roots but otherwise is a small and simple tooth with a slight heel, much as in *Eudaemonema* or *Cynodontomys*. P_3 is more progressive in having the anterior basal cuspule, barely indicated on P_2, more distinct and the heel wider and more definite, but not basined. In marked distinction from any other genus referred to the family, P_4 has a large and prominent paraconid, anteromedian in position. The talonid is basined but is relatively smaller than in *Eudaemonema* or *Cynodontomys* and differs from either in having the entoconid as high and prominent as the hypoconid.

The lower molars have been described in some detail in *E. elegans* (Simpson, 1927) and differ very little in the present species. They have rather higher crowns than in *Cynodontomys* and are marked by the elevation of the internal cusps, metaconid and entoconid, over the obliquely opposite protoconid and hypoconid, a feature suggested in *Cynodontomys* but more prominent in the present genus. The metaconids are slightly anterior, not posterior, to the protoconids. The hypoconulid on M_{1-2} is also still closer to the hypoconid, almost forming with it a single, twinned apex. The same features and also the lesser elevation of the trigonids over the talonids distinguish these molars from those of *Eudaemonema*.

The symphysis was sutured but unfused. The horizontal ramus is

stout, with mental foramina under P_2 and between P_3 and P_4. The masseteric fossa is deep but with a flat bottom and is bounded anteriorly by a sharp crest. The internal aspect of the postdental region is flattened but peculiarly sculptured, as shown in the figure.

In the light of the present greatly expanded knowledge, it is obvious that *Elpidophorus* has nothing to do with the "oxyclaenids" (arctocyonids) or other creodonts but is related to the mixodectids, more particularly to the known Eocene forms. Its closest ally is apparently *Cynodontomys* which it strongly resembles throughout. Although unquestionably older than *Cynodontomys*, it has few or no characters than can definitely be counted as more primitive, with the exception of the lesser reduction of the (lower) anterior teeth. The molarization of the premolars is, indeed, slightly more advanced at least in the lower and probably also in the upper dentition and such a feature as the prominent paraconid of P_4 is probably an aberrant specialization. The molar structure is indeed very close to *Cynodontomys*, yet also has a peculiar aberrant and specialized aspect, particularly in the elevation of the inner side of the lower molars and in the alignment of cusps so that the protoconid-metaconid and hypoconid-entoconid lines are oblique and are parallel to each other, probably correlated with the development in the upper molars of a straight, slightly oblique, transverse, median valley from the outer base of the protocone across the mesostyle. *Elpidophorus* cannot be exactly ancestral to *Cynodontomys* or its close ally or descendant *Microsyops*. *Eudaemonema* would be an almost ideal ancestor for *Cynodontomys* and perhaps also for *Elpidophorus* except for the peculiarity that its upper molars have large hypocones as in *Mixodectes*. It is not altogether impossible that the hypocones were secondarily reduced in this line, but it is contrary to the history of practically all contemporaneous forms and so requires better proof before being very seriously considered.

The discovery of *Elipidophorus* and of *Eudaemonema* tends to enhance the probability that *Mixodectes* and its allies are really related to *Cynodontomys* and *Microsyops*, yet it also shows that the group is a complex one and that our knowledge is of isolated stages of several different phyla and not of a single structural sequence. The subfamily division into Mixodectinae and Microsyopinae are defined by Matthew (1915, p. 467) breaks down in the light of these later discoveries. The Mixodectinae were defined as having the antemolar dentition less reduced, the premolars not molariform, the upper molars with strong hypocone. The Microsyopinae were defined as having the antemolar

dentition more reduced and perhaps not homologous, the premolars progressively molariform, and the upper molars with weak hypocone. Neither *Eudaemonema* nor *Elpidophorus* enters into either subfamily as defined, yet they are related to the members of both subfamilies. To define new subfamilies for them would be essentially to raise each truly distinctive genus to subfamily rank, which would be highly disadvantageous. *Eudaemonema* has the antemolar dentition still less reduced than in the "Mixodectinae" and has "microsyopine" premolars and "mixodectine" molars. *Elpidophorus* has the anterior dentition more as in the "Mixodectinae" and has the premolars and molars more of "Microsyopine" type, but somewhat aberrant from either supposed subfamily.

In several of its distinctive characters *Elpidophorus* makes a definite approach toward the Plagiomenidae. It is not ancestral to the latter, for the typical plagiomenid *Planetetherium* must be almost contemporaneous, and it is decidedly closer to the Mixodectidae, yet to a considerable extent it does tend to bridge the structural gap between the two families. It may well prove that they had a common origin.

Elpidophorus helps very little with the difficult and much argued broader question of the affinities of the Mixodectidae. It adds nothing in favor of either of the two most definite suggestions that have been made: that they are rodents (or prorodents) or that they are primates. The family is referred to the Insectivora, following Matthew, mainly because there is no good reason to place them anywhere else. They have few diagnostic insectivore characters. They may well prove to be another of the numerous minor lines that diverged from the relatively little differentiated placental stock at a very early date, without any particular relationship to any of the more long-lived and specially designated orders, and that ran a relatively brief course without ever developing into anything striking enough for major distinction in taxonomy. Probably the best thing that can be done with all such taxonomic loose-ends is to tidy up by throwing them in the Insectivora as a scrap-basket.

? INSECTIVORA, INCERTAE SEDIS

APATOR[1] NEW GENUS

TYPE.—*Apator asaphes*, new species.

DISTRIBUTION.—Upper Paleocene, Fort Union, Montana.

DIAGNOSIS.—P_4 one-rooted, very short and tall, with single cusp followed by small heel. M_{1-2} with strongly elevated trigonids, metaconid slightly lower than

[1] ἄπατωρ, orphan—from its apparent lack of relatives.

protoconid, paraconid still lower but strong and distinct, nearly internal, talonids with large hypocones, small median hypoconulids, and entoconids vestigial, basin widely open on internal side. Talonid slightly wider than trigonid on M_1, distinctly narrower than trigonid on M_2.

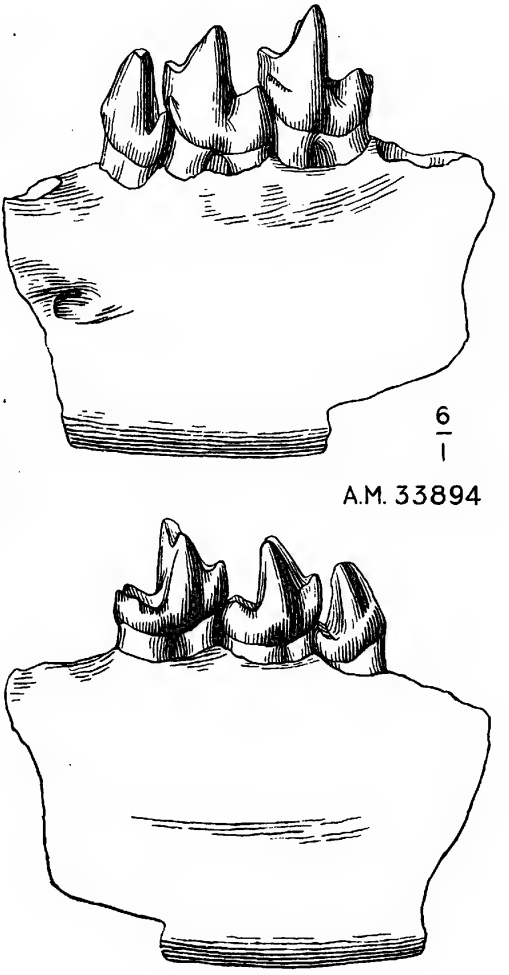

Fig. 7. *Apator asaphes*, new genus and species. Type, Amer. Mus. No. 33894, left lower jaw with P_4–M_1. External and internal views. Six times natural size.

This genus has the simple molar structure usually associated with the Insectivora, but not in itself diagnostic of that Order. I am not acquainted with any genus with which it can be confused or with which it seems to be closely related, and its affinities are very dubious. This is true even if the teeth known in the type prove to be P_3–M_1 rather than P_4–M_2, a possibility mentioned below.

Apator asaphes,[1] new species

TYPE.—Amer. Mus. No. 33894, left lower jaw with P_4–M_2 and alveoli. Collected by the Third Scarritt Expedition.

HORIZON AND LOCALITY.—Scarritt Quarry, Fort Union, Upper Paleocene horizon, Crazy Mountain Field, Montana.

DIAGNOSIS.—Sole known species of genus. Measurements given below.

At the anterior end of the single specimen, as preserved, there is a very small alveolus, probably for a vestigial tooth. This is followed by a short diastema, beneath which is the prominent posterior mental fora-

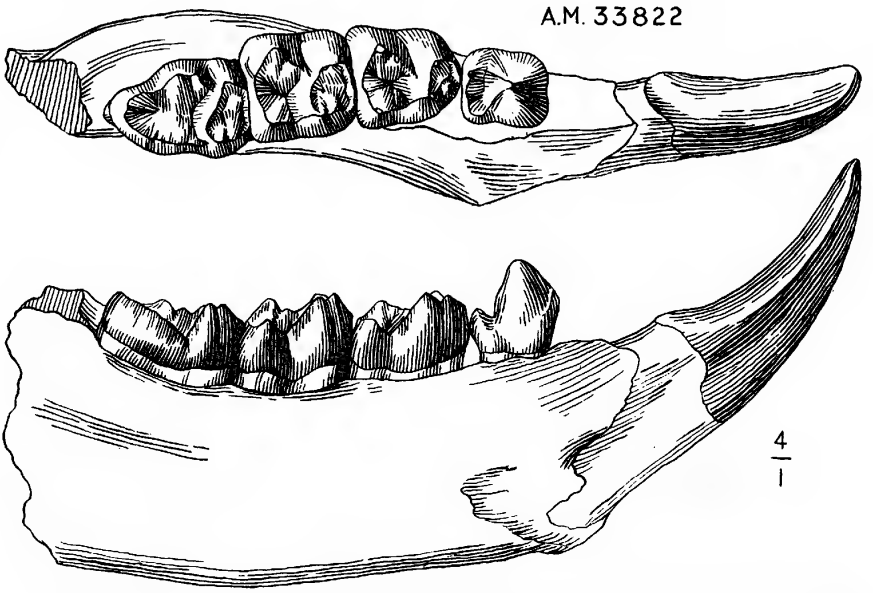

Fig. 8. *Plesiadapis anceps,* new species. Type, Amer. Mus. No. 33822, left lower jaw with M_{1-3}, and P_4 reversed from right side. Some distortion in the placing of M_{1-3} has been corrected. Crown and internal views. Four times natural size.

men, and then by the three teeth preserved. These teeth are adequately described in the generic diagnosis and shown in the figure. They are followed by two alveoli, the more posterior of which is not completely preserved but was evidently narrower and more elongate than the anterior.

It is possible that the teeth preserved are P_3–M_1, and this is suggested by the fact that the third is farther out of the alveoli than the second, but I believe this to be accidental, post mortem, and that the

[1] Ασαφής, vague.

teeth are very probably P_4–M_2. It is more normal for the posterior mental foramen to be immediately anterior to P_4 than to P_3. The two molariform teeth are about equally worn. The more anterior of them is more completely molariform than a P_4 usually is, and their structural relations and proportions are those usual for M_1–M_2 and extraordinary for P_4–M_1. The alveoli posterior to them strongly suggest the shape of roots usual for M_3 and very rare for M_2.

The jaw is deep relative to the teeth, which have the following dimensions:

P_4		M_1		M_2	
L	W	L	W	L	W
1.4	0.9	2.3	1.6	2.5	1.7

PRIMATES

Plesiadapidae

Plesiadapis anceps, new species

TYPE.—Amer. Mus. No. 33822, left lower jaw with incisor and M_{1-3}, right P_4 and M_1, right P^3–M^1, left M^{1-2}, and other fragments, all of one individual.

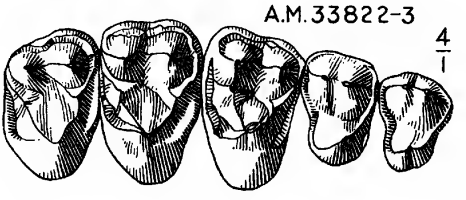

Fig. 9. *Plesiadapis anceps*, new species. Right P^3–M^3. P^3–M^1 are taken from the type, Amer. Mus. No. 33822, M^2 is reversed from the left side of the same individual, and M^3 is from a different individual, Amer. Mus. No. 33823. Crown view. Four times natural size.

Fig. 10. *Plesiadapis anceps*, new species. Amer. Mus. No. 33824, upper incisor. Lingual view. Four times natural size.

HORIZON AND LOCALITY.—Scarritt Quarry, Fort Union, Upper Paleocene horizon, Crazy Mountain Field, Montana.

DIAGNOSIS.—Close to *P. gidleyi* in size and structure, but conule absent on P^3, small on P^4; upper molars without mesostyles; M^1 more symmetrical with postero-

internal basin less developed; M^3 less rounded, quadrate, with metacone less reduced and posterointernal expansion less, P_4 without paraconid or metaconid and even simpler than in *P. gidleyi* with considerably smaller and less basined heel, M_{1-2} relatively heavy and wide, M_2 almost perfectly square; M_3 with heel markedly less expanded than in *P. gidleyi*, third lobe narrower.

This species is larger than the average for *P. gidleyi* (see measurements below) but is within its probable size range and is manifestly related to it, so that at first glance it might even seem to be of that species. On closer examination, however, it is seen to differ in morphological details almost in every tooth and its specific distinction seems certain, especially as the variation of *P. gidleyi* is well established.

The dental formula cannot be established and it is unknown whether P_2 was present. This tooth is present in all known specimens of *P. gidleyi*, and absent in other species referred to the genus. In addition to the distinctions mentioned in the diagnosis are the somewhat less marked or less certain points that an isolated upper incisor, evidently of *P. anceps*, is more slender than that of *P. gidleyi*, with the external apical cusp relatively less prominent and with no lingual accessory cuspule; that P^4 seems to be slightly less transverse and less symmetrical; and that the lower incisor has the basal cuspule less definite than is usual in *P. gidleyi*.

Several of these characters, notably the absence of a mesostyle on the upper molars and the extreme simplicity of P_4, are resemblances to *Pronothodectes*. This new and apparently primitive morphological variant adds to the difficulty of generic classification in this group, to which attention has already been directed (especially Jepsen, 1930, Simpson, 1935a). Evidently the Plesiadapidae had a very complex phyletic history which we cannot yet unravel, and classification will be tentative until more is known.

Measurements of the type follow:

P_4		M_1		M_2		M_3	
L	W	L	W	L	W	L	W
2.6	2.1	3.1	2.9	3.4	3.3	4.4	3.0

P^3		P^4		M^1		M^2	
L	W	L	W	L	W	L	W
2.0	2.7	2.4	3.2	3.0	4.5	3.2	5.0

An isolated M^3 measures 2.9 by 4.5.

Carpolestidae

Carpodaptes hazelae,[1] new species

TYPE.—Amer. Mus. No. 33854, right lower jaw with P_4–M_3.

HORIZON AND LOCALITY.—Scarritt Quarry, Fort Union, Upper Paleocene horizon, Crazy Mountain Field, Montana.

DIAGNOSIS.—Closely similar to *Carpodaptes aulacodon* in size and structure, but P_4 more quadrate in horizontal outline, apical cusps five in number, more distinct and prominent, more widely spaced, crest of tooth rising to a less definite point. M_{1-2} slightly more compressed anteroposteriorly and M_3 with third lobe more distinctly set off from second.

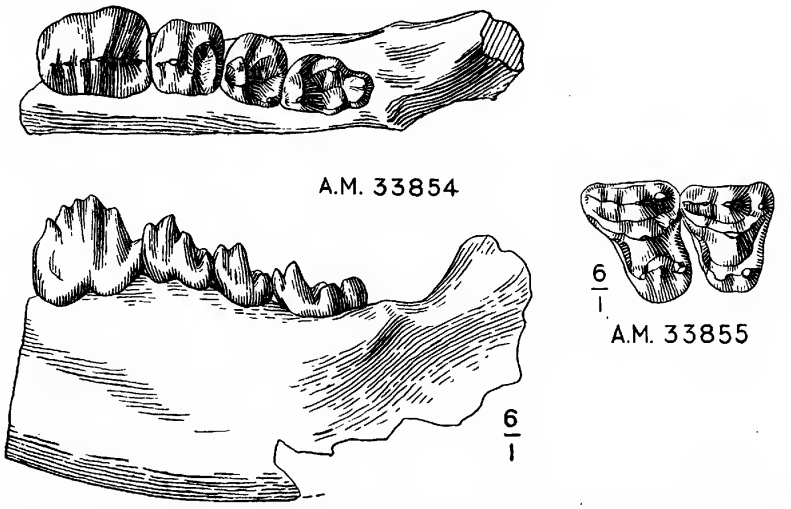

Fig. 11. *Carpodaptes hazelae,* new species. Type, Amer. Mus. No. 33854, right lower jaw with P_4–M_3. Crown and internal views. Six times natural size.

Fig. 12. *Carpodaptes hazelae,* new species. Amer. Mus. No. 33855, P^{3-4}. Crown view. Six times natural size.

Slight as the distinctions of this interesting species from *C. aulacodon* are, they do to that slight extent resemble the earlier *Elphidotarsius.* P_4 is, however, decidedly more enlarged than in the latter and has one more apical cuspule. Generic affinities are clearly with *Carpodaptes* rather than with *Elphidotarsius,* and are more distant from *Carpolestes,* the most specialized of the three genera.

An isolated jaw fragment contains P^{3-4}, hitherto known only for *Carpolestes dubius* in this family (Jepsen, 1930). In the present species

[1] To Mrs. Hazel Hunter who, with Mr. Hunter, accompanied the collecting party for a month. Also in analogy with *Elphidotarsius florencae,* an earlier relative of this species from the same field, which is named for Mrs. Gidley.

those extraordinary teeth resemble those described by Jepsen, but are somewhat simpler and more clearly suggest their possible derivation from more normal P^{3-4} similar to those of *Plesiadapis*.

P^3 and P^4 are closely similar in structure, but differ in outline as shown in the figure. Both are nearly symmetrical and P^3 does not have the anteroexternal spur seen in *Carpolestes*. The outer cusp row consists of four cusps, the middle pair, of which the anterior is larger, evidently corresponding to the poorly separated paracone and metacone of the *Plesiadapis* premolar and the outer (anterior and posterior) pair to the styles. The parastyle is larger than the metastyle and on P^4 is rather obscurely double. The median cusp row is developed rather as an irregular and low crescentic ridge, concave externally, on which one more definite and one or two other very vague cuspules tend to be localized. This apparently corresponds to the conule mass of P^4, and usually also P^3, in *Plesiadapis*. The inner side of the tooth is a subquadrate lobe with one main cusp, evidently the protocone. On P^3 this seems to be anterointernal, although vague, and to be followed by a heel, while on P^4 it is median-internal and has a tiny accessory cuspule anterior and another posterior to it.

Dimensions of the type are as follows:

P_4		M_1		M_2		M_3	
L	W	L	W	L	W	L	W
2.3	1.8	1.4	1.6	1.2	1.5	1.9	1.3

P_4–M_3: 7.0

Family Uncertain

Phenacolemur frugivorus (Matthew and Granger, 1921)

Amer. Mus. No. 33896 is a left lower jaw with P_4–M_2, with alveoli for M_3 and for the enlarged anterior tooth. There seems to be no distinction of probable specific value between this specimen and those of *Phenacolemur frugivorus* from the Tiffany, and it must be referred to that species despite the inherent improbability of a single, minute species being common to two localities so distant from each other and probably not of quite the same facies or age. The dimensions are as follows:

P_4		M_1		M_2	
L	W	L	W	L	W
1.6	1.1	1.9	1.4	1.8	1.5

None of these dimensions differs by more than 0.2 mm., or 13 per cent, from those of the known Tiffany specimens.

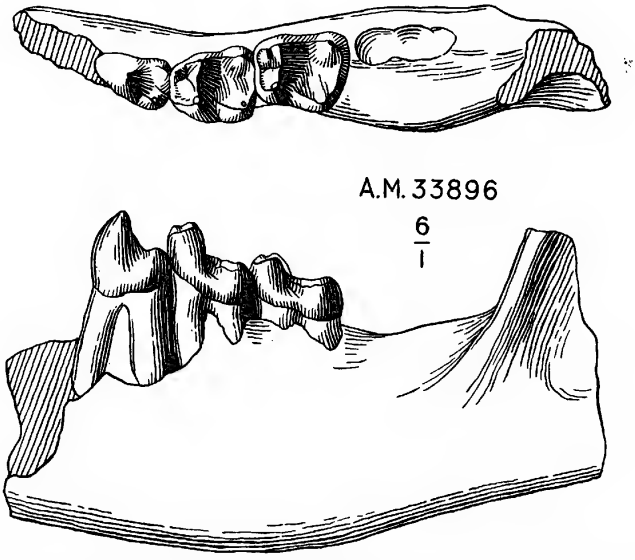

Fig. 13. *Phenacolemur frugivorus* (Matthew and Granger, 1921). Amer. Mus. No. 33896, left lower jaw with P_4–M_2. Referred specimen. Crown and external views. Six times natural size.

CARNIVORA

Arctocyonidae

Cf. **Chriacus** sp.

Arctocyonids are definitely represented in this faunule only by a broken upper molar including most of the inner half of the tooth. It very closely resembles the corresponding parts of the type of *Chriacus orthogonius* Russell from the Paskapoo, but is larger (about 25 per cent). It is inadequate for identification.

CONDYLARTHRA

Hyopsodontidae

Litolestes notissimus, new species

TYPE.—Amer. Mus. No. 33831, left lower jaw with P_2–M_3 (slightly broken), right upper with P^1–M^3, and left upper jaw with canine and P^{1-3}, all of one individual.

PARATYPE.—Amer. Mus. No. 33830, right lower jaw with P_2–M_3.

HORIZON AND LOCALITY.—Scarritt Quarry, Fort Union, Upper Paleocene horizon, Crazy Mountain Field, Montana.

DIAGNOSIS.—Larger than *L. ignotus*. P_4–M_3 (eight specimens) mean 7.54 ± .07,

standard deviation .21 ± .05. Deviation of (paratype of) *L. ignotus* from the mean is 6.3 times this standard deviation. Heel of P_4 with two cusps and a minute basin.

This is the most abundant species in the collection and is represented by excellent material exhibiting almost all the dental characters. *Litolestes ignotus*, the genotype, was described by Jepsen (1930) from the "Tiffany-Bear Creek" level of the Fort Union of northern Wyoming,

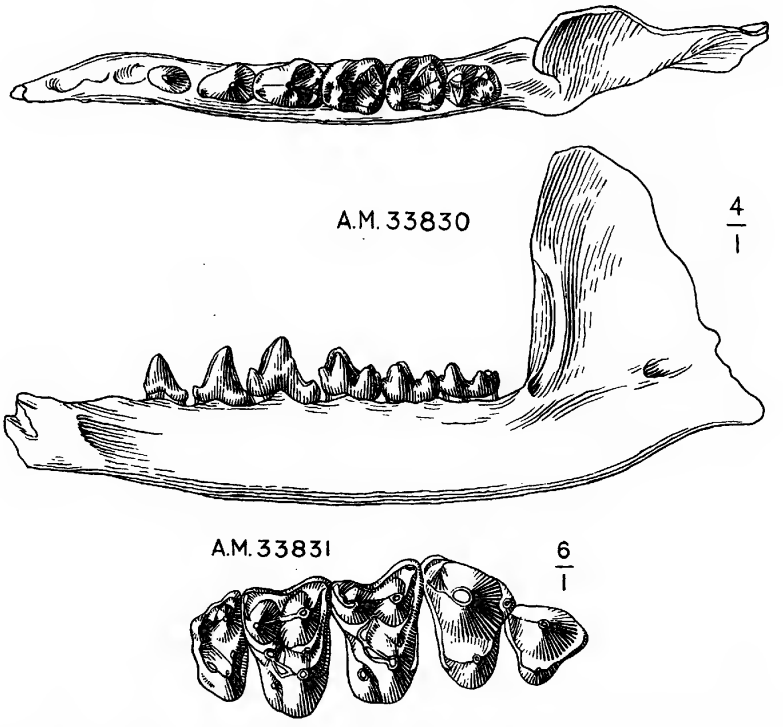

Fig. 14. *Litolestes notissimus*, new species. Paratype, Amer. Mus. No. 33830, right lower jaw with P_2–M_3. Crown and internal views. Four times natural size.

Fig. 15. *Litolestes notissimus*, new species. Type, Amer. Mus. No. 33831, right P^3–M^3. Crown view. Six times natural size.

and was referred to the Insectivora (in a faunal list to the Leptictidae) with a query and with the comment that the reference was uncertain, the remains available to Jepsen not demonstrating relationship to other forms. The present species agrees with *L. ignotus* in most respects but has a fairly constant size difference of about 20 per cent, not great but demonstrated to be statistically significant. In general the cusps are sharper and more clear-cut in *L. ignotus* and P_4 is more elevated, with

the metaconid usually more distinct. P_3 is shorter, generally smaller, less elevated, and more triangular in horizontal section. On present data these differences seem less than generic. The following description and discussion are based entirely on *L. notissimus*.

The upper canine is a long, slender, recurved tooth of almost laniary type. P^1 is very small and simple, with only one slender cusp, but has two roots. P^2 is slightly larger, less compressed transversely and has a small, non-cuspidate posterior heel. P^3 is abruptly larger and has three roots. It has small parastylar and metastylar projections, the latter larger, but these barely form cuspules. The protocone is only very slightly larger than the metastylar spur, but rises into a small distinct cusp. There are slight anterior and posterior, but no external, cingula. P^4 is larger and particularly more transverse, with a larger protocone. The amphicone is a large circular cusp with a curving crest on its posterior face only. There is a vague tendency to pinch off a second cusp on this crest, but this is so very slight that the separation of paracone and metacone may be said to be entirely absent. Slight external cingula start from the parastyle and metastyle, but do not meet across the outer face.

M^1 and M^2 are closely similar, but the latter is more transverse. Paracone and metacone are well separated and are subequal. The protocone is rather low and heavy and has the usual crescentic form. Both conules are distinct. There is a slight anterior cingulum and a more developed posterior cingulum ending in a small but distinct hypocone almost directly posterior to the protocone. The prominent external cingulum is angulate in the parastylar and metastylar corners and emarginate in the middle. M^3 is strongly transverse, with a strong parastylar spur, reduced metacone, no metastyle, and a posterior cingulum but no distinct hypocone.

The symphyseal region of the mandible is much elongate and slender and judging from rather vague alveoli carried tiny unspecialized incisors and a canine less enlarged than the upper canine. P_1 is not preserved but seems to have had only one very small alveolus. P_2 and P_4–M_3 are almost exactly as in *L. ignotus*, well described by Jepsen, and are shown in the accompanying figures. P_3 is triangular in outline, much like P_4 in this respect, but smaller, with no trace of a metaconid and with a smaller heel with a single cuspule and no definite basin.

Although markedly different from such diversely specialized forms as *Mioclaenus*, on one hand, or *Hyopsodus*, on the other, this genus is connected to the Hyopsodontidae (plus Mioclaenidae) by numerous

intermediate types which it resembles closely, and it does not more nearly resemble any genera referred to other families. Closest comparison seems to be with such types as *Litaletes*[1] or *Haplaletes* from the Gidley Quarry level of this field. The resemblance to *Haplaletes* is particularly close, and seems to establish the relationship beyond much question. The principal distinctions, apparently of not more than generic value, are the less compressed amphicones of P^{3-4} in *Litolestes*, its more transverse upper molars with more angulate external corners, its slightly smaller metaconid and talonid basin on P_4, and its less elongate talonid on M_3.

The length P_4–M_3 is taken as a standard of size comparison, since it is given by Jepsen for *L. ignotus*, and can be measured on eight of the present specimens. Its constants in our sample are as follows:

Variate	No.	Range	Mean	Standard Deviation	Coefficient of Variation
LP_4–M_3	8	7.1–7.8	7.54 ± .07	.21 ± .05	2.8 ± .7

Dimensions of the type upper teeth are as follows:

P^3		P^4		M^1		M^2		M^3	
L	W	L	W	L	W	L	W	L	W
1.6	1.5	2.1	2.2	2.1	2.6	1.7	2.7	1.4	2.4

Dimensions of the paratype lower teeth are as follows:

P_3		P_4		M_1		M_2		M_3	
L	W	L	W	L	W	L	W	L	W
1.7	1.1	2.1	1.4	2.0	1.6	1.6	1.6	1.6	1.3

Fig. 16. *Tetraclaenodon* sp. Amer. Mus. No. 33898, right upper molar. Crown view. Twice natural size.

Phenacodontidae

Tetraclaenodon sp.

Amer. Mus. No. 33898 is a right upper molar, probably M^1, of a phenacodont wholly lacking a mesostyle. Despite the *a priori* im-

[1] The resemblance in names is wholly accidental, as the affinities of *Litolestes* were unsuspected when *Litaletes* was described and the names are derived from different roots.

probability of finding *Tetraclaenodon* at this level, with genera elsewhere associated with the more advanced genus *Phenacodus*, nothing separates this tooth from *Tetraclaenodon*, and it certainly is not *Phenacodus*, *Ectocion*, or *Gidleyina*. It is about the size of *T. plicifera*, smaller than *T. symbolicus* and still more distinct from *T. puercensis*.

PANTODONTA[1]

Pantolanbdidae

Gen. et sp. indet.

The outer part of an upper premolar and a badly broken lower cheek tooth suggest this family, but differ in some respects from either *Pantolambda* or *Titanoides*, the only genera so far defined. They are inadequate for any more exact determination, but their presence is worth mentioning and search for better remains of this peculiar animal should be made.

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1935b. 'New Paleocene mammals from the Fort Union of Montana.' Proc. U. S. Nat. Mus., LXXXIII, pp. 221–244.

[1] The use of the name "Pantodonta" for an order including pantolambdids and coryphodonts but excluding periptychids and uintatheres will be explained and defended in the memoir on the National Museum Fort Union collection.